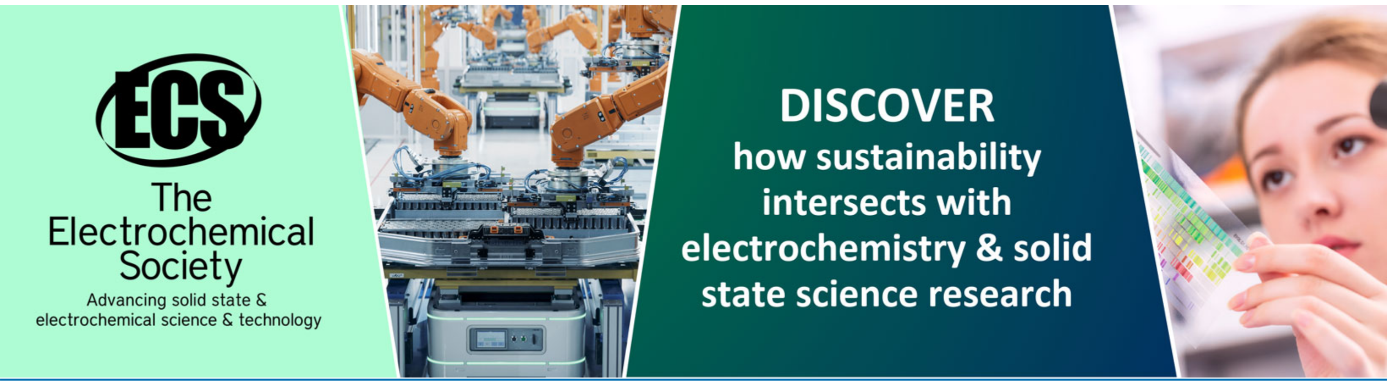
Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

Air pollution Indexes Over Buchanan: Danger and Control

To cite this article: M.E. Emetere *et al* 2019 *J. Phys.: Conf. Ser.* **1299** 012004



IOP Conf. Series: Journal of Physics: Conf. Series **1299** (2019) 012004 doi:10.1088/1742-6596/1299/1/012004

Air pollution Indexes Over Buchanan: Danger and Control

Emetere M.E.[1,2], OkoroEmeka Emmanuel[3], Sanni E. Samuel[4]Akinyemi M.L.[1] and Emetere J.M.[5]

[1]Department of Physics, Covenant University Canaan land, Ota, Nigeria.
[2]Department of Mechanical Engineering & Science, Univ. of Johannesburg, APK, South Africa
[3]Petroleum Engineering, Covenant University Ota, Nigeria
[4]Chemical Engineering, Covenant University Ota, Nigeria
[5]Department of Mathematics, Federal University of Technology, Minna Nigeria.

Contact email:emetere@yahoo.com

Abstract. In this paper, the air pollution state of Buchanan-Liberia was investigated. Fifteen years primary (aerosol optical depth) dataset was obtained from the Multi-angle Imaging Spectro-Radiometer (MISR). The secondary datasets that was generated from the primary dataset is a new concept to air quality monitoring i.e. aerosol loading. The statistical analysis of the dataset was also presented. The standard deviation of the AOD is found to be less than 0.15 and maximum AOD value of 1.15. The average aerosol loading over Buchanan is 0.87. Statistically, the difference between the first and third quartile of the dataset indicates that there is considerable dispersion of aerosol content into the atmosphere in the months of June and December. The dataset gives a preliminary insight on how aerosol loading can be used extensively for preliminary ground exploration in Buchanan.

1. Introduction

The World Health Organization prediction on the increase of deaths (caused by air pollution) over certain regions of the world has received little attention in most cities in Africa [1]. The mean annual concentration of fine suspended particulates of less than 2.5 micron in diameters (as presented in Figure 1) can be used to estimate the level of pollution the study area [2-5]. The aerosol loading is a new parameter for estimating air pollution [6,7]. By definition, aerosol loading is the accumulation of aerosols or particulates in the atmosphere over the years. Aerosols are sustained in the atmosphere as long as their lifetimes. Aerosol loading may be partially reduced by rainfall or wind activities [8]. Aerosol loading was first introduced mathematically by the West African regional scale dispersion model [9]. The West African regional scale dispersion model (WARSDM) was borne by the desperate intention of creating a platform for understanding air pollution over West Africa. Ground and satellite dataset was synchronized to generate the atmospheric constant of some cities in West Africa. The input dataset in WARSSDM is the aerosol optical depth (AOD). AOD has shown tremendous importance in understanding atmospheric features [5]. Hence, the focus of this paper is to estimate the air pollution indexes over Buchanan-Liberia. The usefulness of the data presented in this paper is essential to: give a good background for further study on aerosol loading; provide meteorological centers insight towards configuring sun-photometer over Buchanan-Liberia; help quantify the extent of air pollution; provide start-up knowledge of aerosol loading and retention challenges over Buchanan-Liberia.

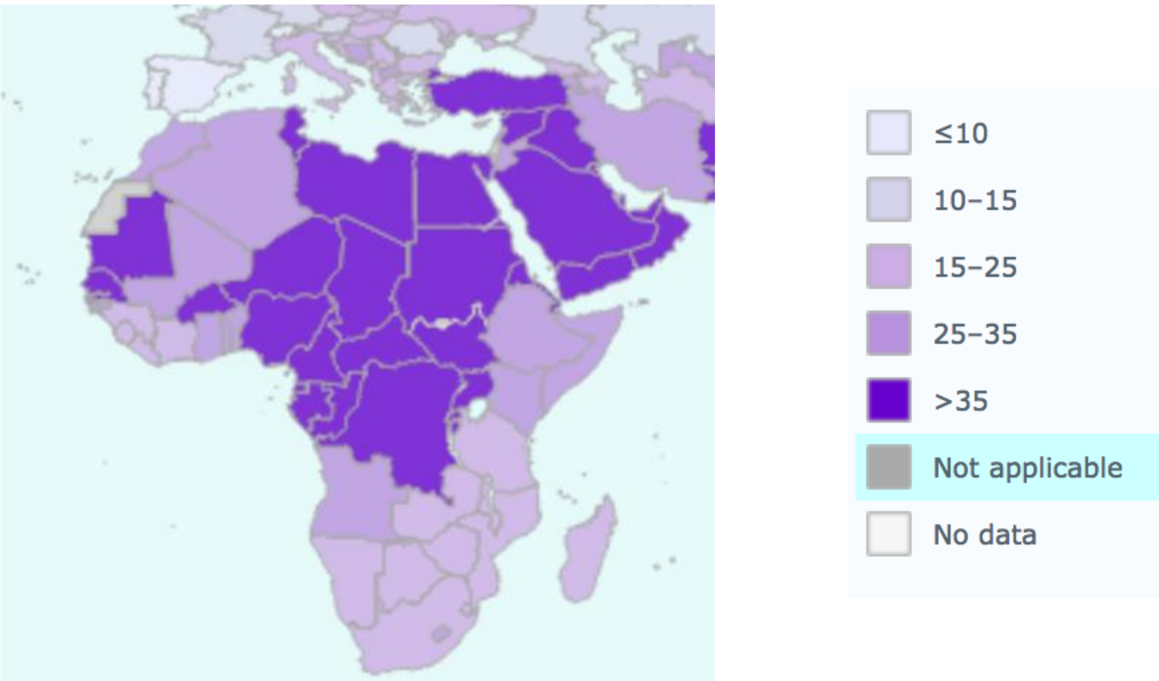


Figure 1: Mean annual concentration of fine suspended particulates of less than 2.5 micron

2. Experimental Design, Materials and Methods

Buchanan is the third largest city in Liberia. Buchanan is located on longitude and latitude of 18.09^o and -15.98^o (Figure 2). The latitude and longitude coordinates for Buchanan are 5°52'51.92"N and 10°2'40.99"W. The dataset was obtained from MISR (https://l0dup05.larc.nasa.gov/L3Web/download). The data was processed using excel. The conversion from AOD to aerosol loading was done using WASDM.

IOP Conf. Series: Journal of Physics: Conf. Series **1299** (2019) 012004 doi:10.1088/1742-6596/1299/1/012004

5

Figure 2: Geographical map of Buchanan

The dispersion modalities over the region agrees with WASDM and it is mathematically represented by the listed governing equations i.e.

$$\psi(\lambda) = {a_1}^2 \cos\left(\frac{\mathrm{n}_1 \pi \tau(\lambda)}{2} x\right) \cos\left(\frac{\mathrm{n}_1 \pi \tau(\lambda)}{2} y\right) + \cdots \ldots {a_n}^2 \cos\left(\frac{\mathrm{n}_\mathrm{n} \pi \tau(\lambda)}{2} x\right) \cos\left(\frac{\mathrm{n}_\mathrm{n} \pi \tau(\lambda)}{2} y\right) (1)$$

a,$\tau(\lambda)$, and $\psi(\lambda)$are atmospheric constant, AOD and aerosol loading respectively. The dataset was first treated using the Microsoft excell program. The average monthly dataset was obtained before the onward processing via the CERN-Root codes

3. Results and Discussion

The aerosol optical depth shown in Figure 3 reveal the scanty nature of the satellite dataset. Scanty satellite dataset has been deduced to moisture, cloud scavenging, precipitable water content and high rain drop rate [5].The statistical treatment of the dataset is shown in Table 1 below. The results show that the results provide 62 % chances of understanding the full concept of AOD over the study area. The difference between the first and third quartile of the dataset indicates that there is considerable dispersion of aerosol content into the atmosphere between June and December. The sources of the anthropogenic pollution can be traced via the coefficient of variation presented in Table 1. The data presented is peculiar to bush/domestic burning and Sahara dust pollution [5]. Hence, the dataset can be used for in-depth analysis of events over Buchanan. The second step is the computational data treatment presented in Figures 4-7. The computational treatment process is a comparative analysis of AOD wavelengths of 440 nm, 550 nm, 670 nm, and 865 nm. The essence of this method is to show the correlations between each AOD wavelengths. The results further indicate that the main sources of pollution in the study area are derivable from bush/domestic burning and Sahara dust.

IOP Conf. Series: Journal of Physics: Conf. Series **1299** (2019) 012004 doi:10.1088/1742-6596/1299/1/012004

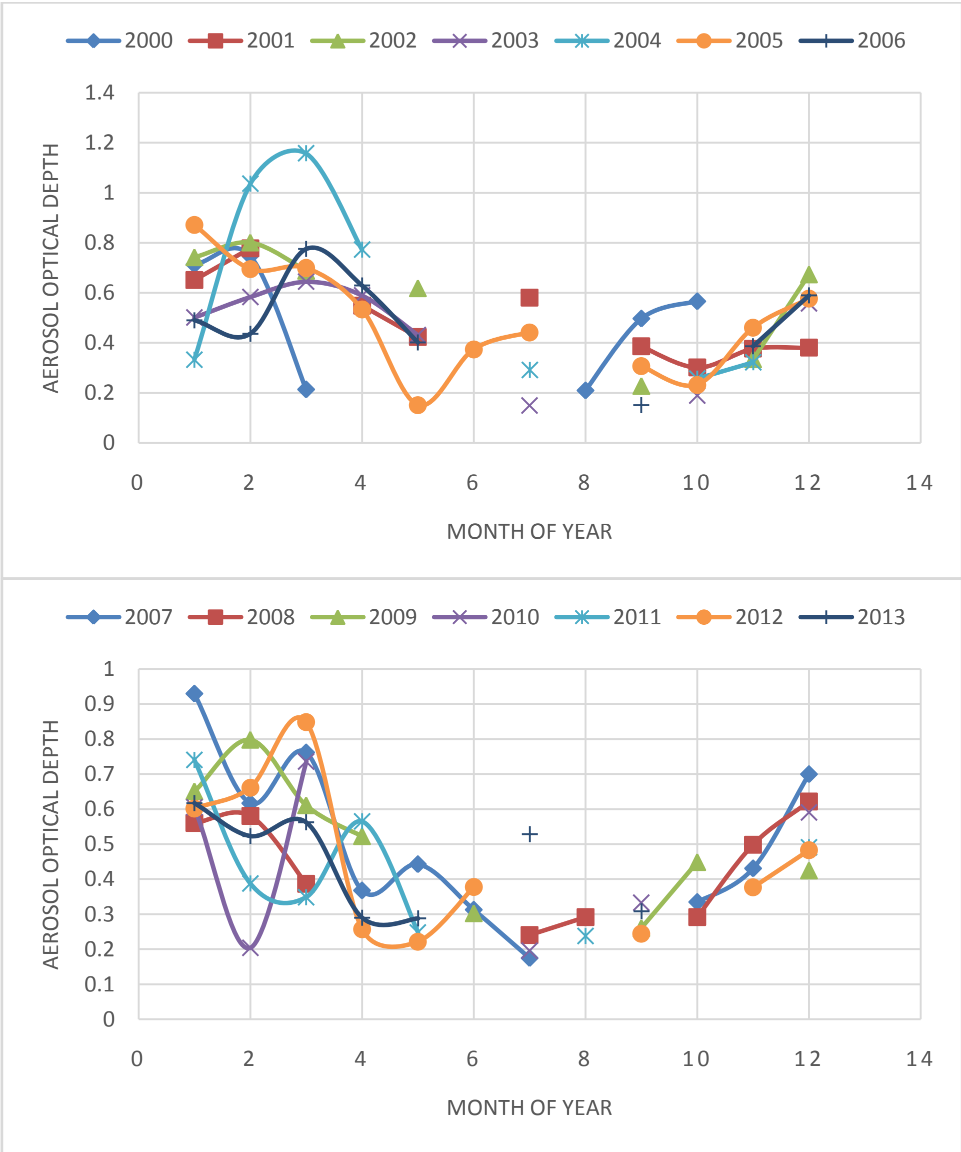


Figure 3: Aerosol optical depth over Buchanan

Table 1: statistics of aerosols content over Buchanan

Statistics	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Number of values	6.000	9.000	7.000	8.000	7.000	11.000	8.000	10.000	8.000	8.000	6.000	7.000	9.000	7.000
Minimum	0.211	0.303	0.228	0.150	0.258	0.152	0.152	0.175	0.241	0.261	0.196	0.238	0.222	0.288
Maximum	0.748	0.779	0.802	0.645	1.158	0.873	0.776	0.931	0.622	0.798	0.736	0.741	0.849	0.617
Mean	0.492	0.493	0.584	0.456	0.597	0.487	0.483	0.508	0.434	0.503	0.444	0.431	0.453	0.445
First quartile	0.215	0.380	0.406	0.311	0.301	0.325	0.395	0.335	0.292	0.364	0.204	0.273	0.254	0.295
Third	0.714	0.600	0.729	0.587	0.971	0.667	0.610	0.700	0.571	0.631	0.605	0.546	0.617	0.554

quartile														
Standard error	0.096	0.052	0.082	0.067	0.146	0.066	0.066	0.075	0.053	0.064	0.094	0.068	0.072	0.054
95% confidence interval	0.247	0.120	0.201	0.157	0.356	0.146	0.157	0.169	0.125	0.151	0.241	0.168	0.165	0.133
99% confidence interval	0.387	0.175	0.304	0.233	0.540	0.208	0.232	0.242	0.185	0.223	0.378	0.254	0.240	0.201
Variance	0.055	0.025	0.047	0.035	0.148	0.047	0.035	0.056	0.022	0.033	0.053	0.033	0.046	0.021
Average deviation	0.186	0.132	0.173	0.149	0.337	0.173	0.139	0.196	0.131	0.143	0.200	0.144	0.174	0.128
Standard deviation	0.235	0.157	0.217	0.188	0.385	0.217	0.188	0.236	0.150	0.181	0.230	0.181	0.215	0.144
Coefficient of variation	0.478	0.318	0.371	0.412	0.646	0.447	0.388	0.465	0.345	0.359	0.518	0.420	0.475	0.323
Skew	-0.357	0.712	-1.022	-1.009	0.663	0.193	-0.243	0.509	-0.062	0.244	0.042	0.717	0.730	-0.196
Kurtosis	-1.916	-0.477	-0.526	-0.573	-1.802	-0.545	0.663	-0.618	-2.045	-0.638	-2.323	-0.150	-0.397	-2.451
Kolmogorov-Smirnov stat	0.214	0.225	0.279	0.221	0.324	0.105	0.180	0.208	0.204	0.117	0.238	0.166	0.192	0.278
Critical K-S stat, alpha=.10	0.468	0.387	0.436	0.410	0.436	0.352	0.410	0.369	0.410	0.410	0.468	0.436	0.387	0.436
Critical K-S stat, alpha=.05	0.519	0.430	0.483	0.454	0.483	0.391	0.454	0.409	0.454	0.454	0.519	0.483	0.430	0.483
Critical K-S stat, alpha=.01	0.617	0.513	0.576	0.542	0.576	0.468	0.542	0.489	0.542	0.542	0.617	0.576	0.513	0.576

IOP Conf. Series: Journal of Physics: Conf. Series **1299** (2019) 012004 doi:10.1088/1742-6596/1299/1/012004

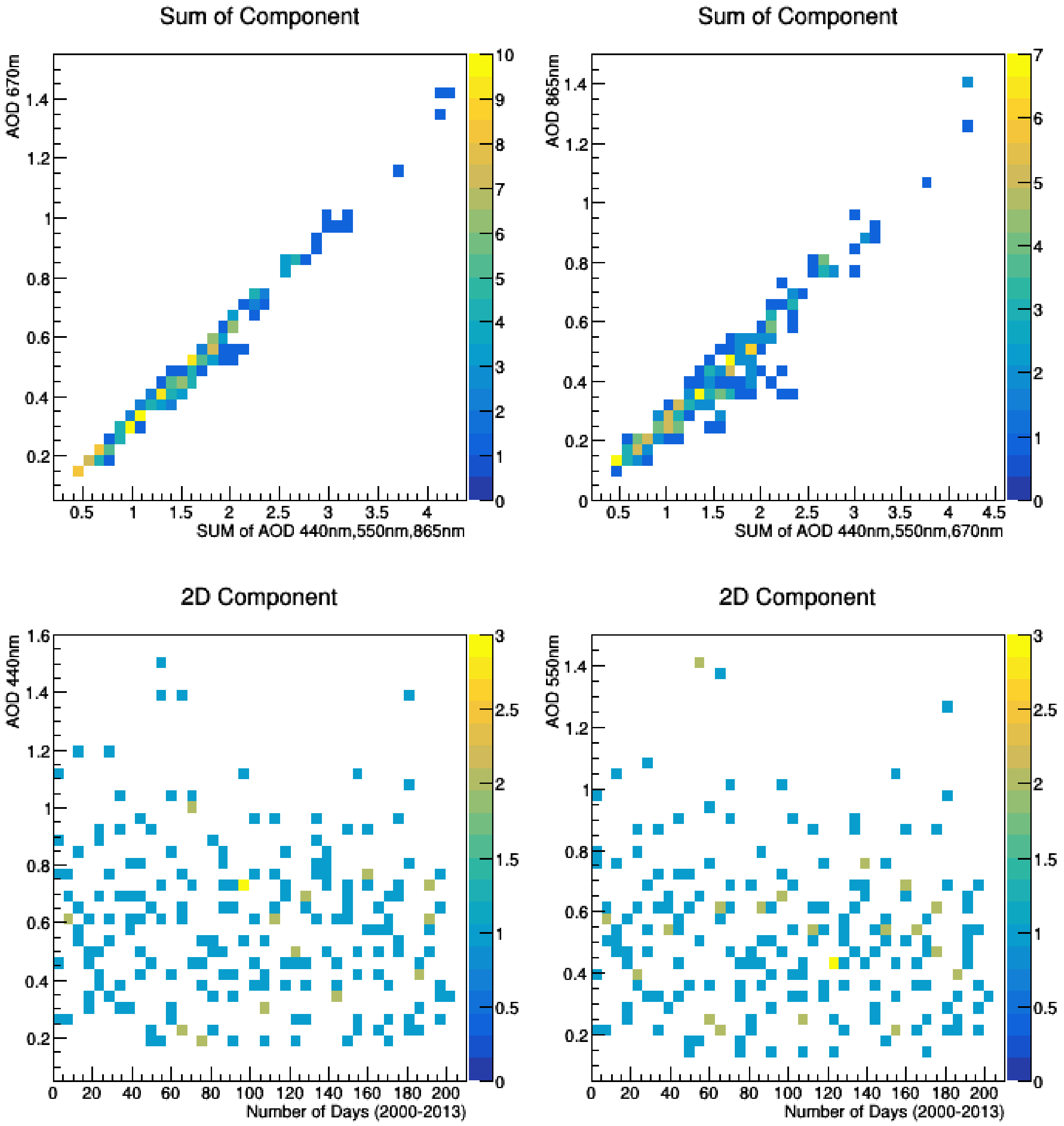


Figure 4: Linear and scattered relationship between 440 nm and 550 nm

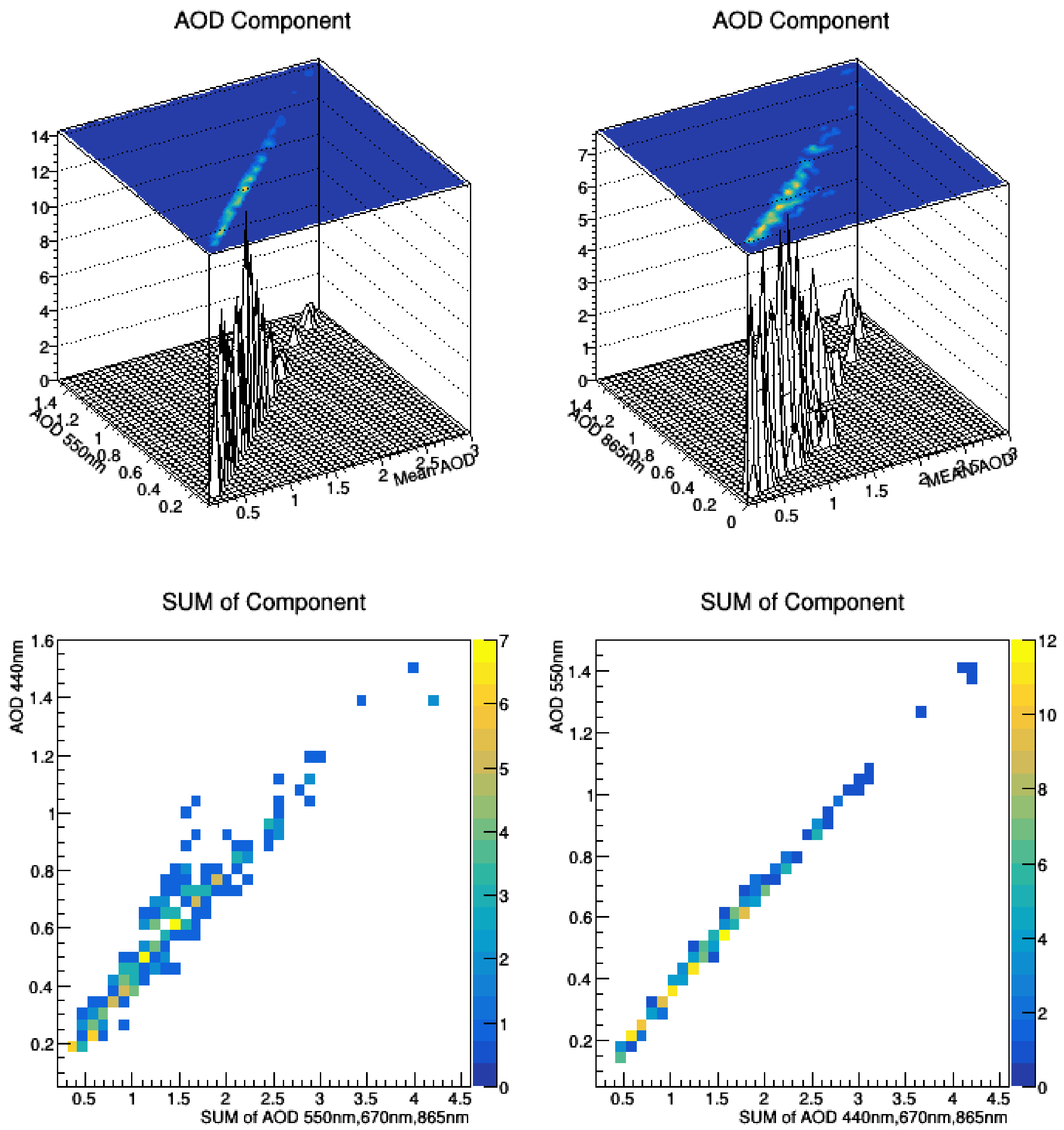


Figure 5: The 3D and scattered plots relationship of 550 nm and 865 nm

The 865 nm and mean AOD (of 440 nm, 550 nm, 670 nm) had higher correlation than the AOD 440 nm and mean AOD (of 865 nm, 550 nm, 670 nm). This means that the data is reliable (Figure 5). The AOD of wavelength 865 nm and 670 nm was tested against other wavelength as presented in Figure 6. The patterns of the 3D representation show that the dataset are reliable. Figure 7 also further confirms the integrity of the dataset for predictive study. For example, it is novel to estimate in precise terms the percentage pollution from different sources. The intersections of the wavelength values give direction as to where ground observation should be directed while the scattered plot gives a rough estimation of period of high aerosol inhalation. More so, Figure 4-7 also revealsthat significant pollution on the coastal region e.g. Buchanan port.

IOP Conf. Series: Journal of Physics: Conf. Series **1299** (2019) 012004 doi:10.1088/1742-6596/1299/1/012004

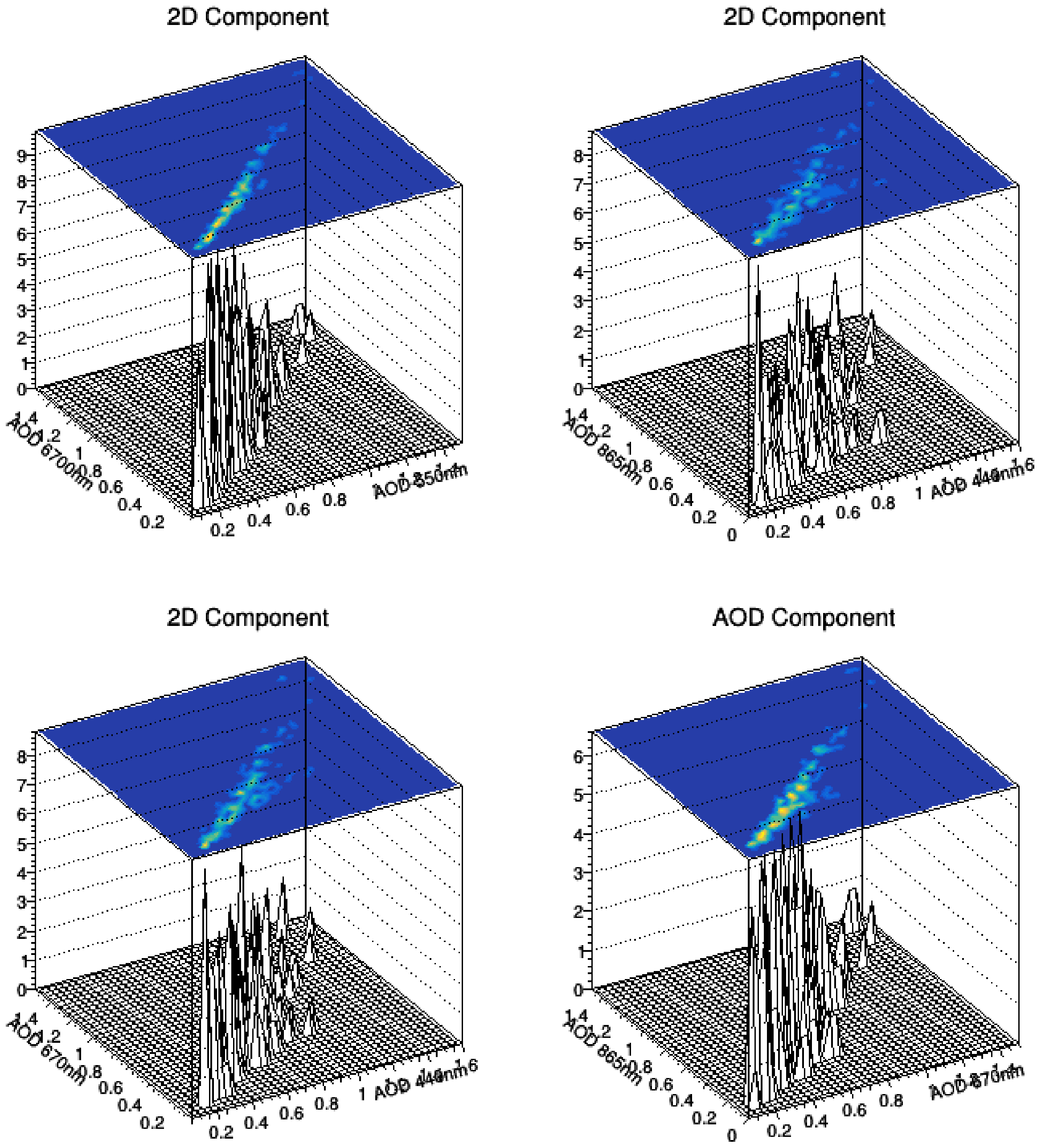


Figure 6: Integrity of AOD of wavelength 865 nm and 670 nm

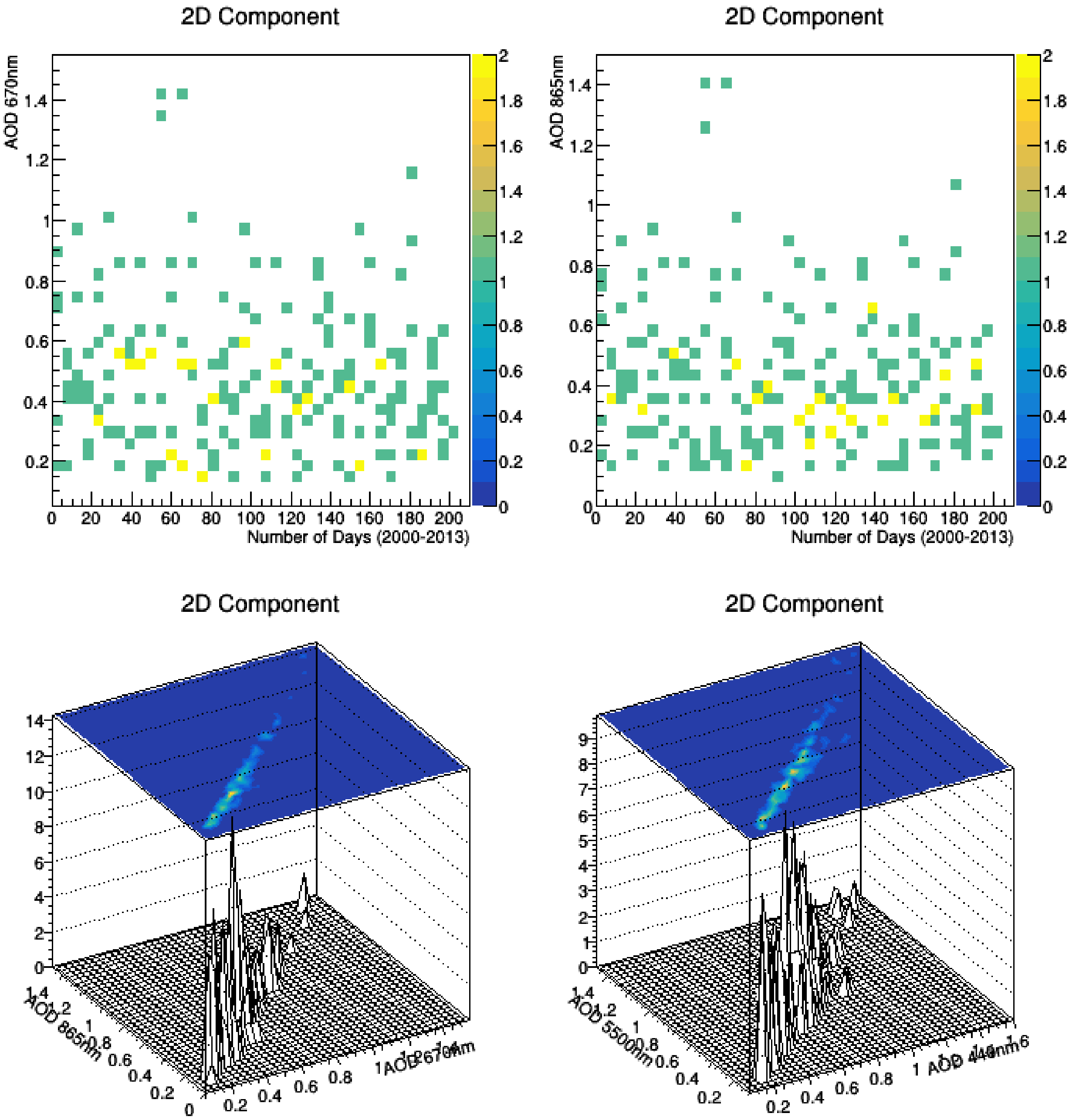


Figure 7: Integrity of AOD of wavelength 865 nm and 670 nm versus wavelength 440 nm and 550 nm

Based on the above results, the WARSDM was used to analyse the AOD of wavelength 550 nm. The aerosol loading was estimated as shown in Figure 8 below. The result presented above, show that the average aerosol loading over Buchanan is about 0.87. This means that life form in the region are already experiencing airborne respiratory disease.

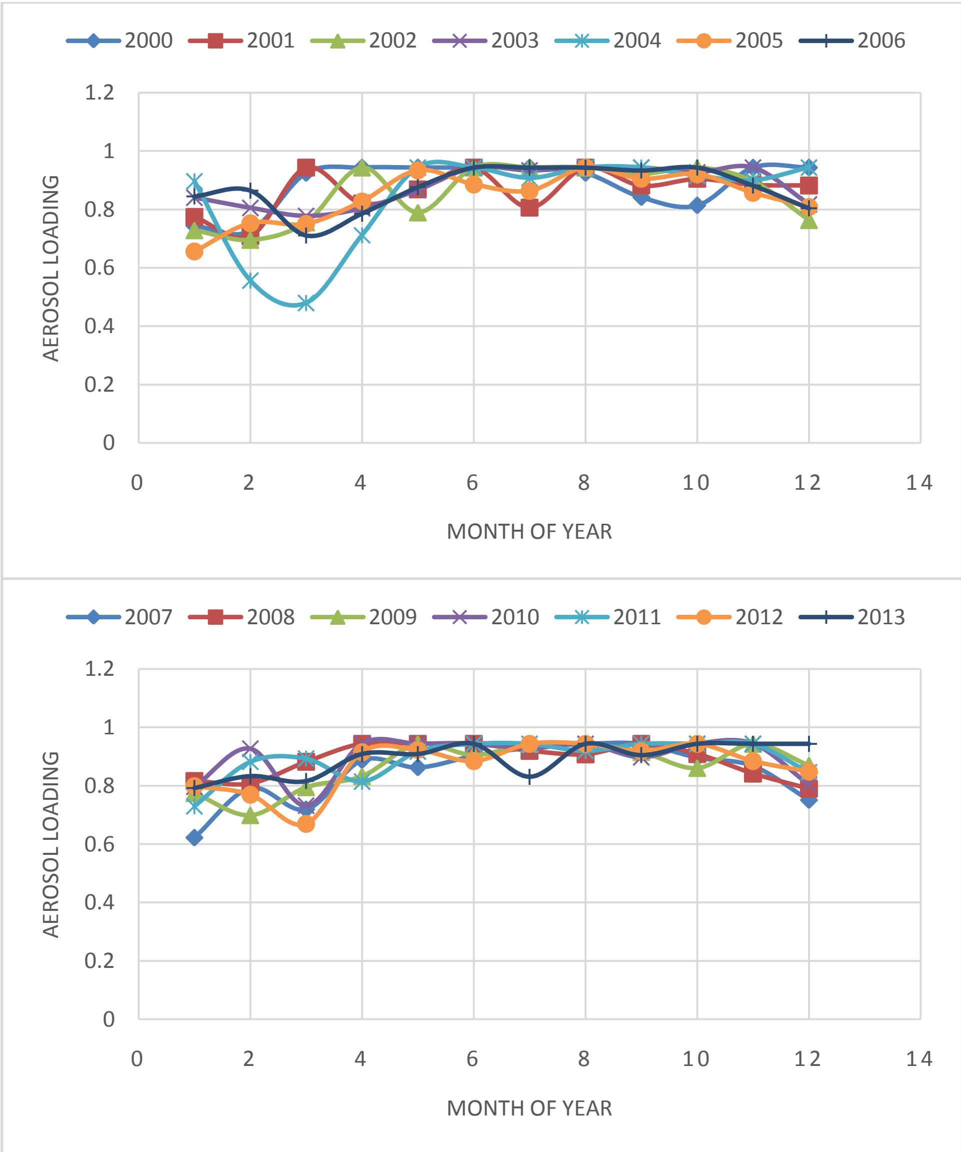


Figure 8: aerosol loading over Buchanan

4. Conclusion

From the high aerosol loading values reported in this research study, there might be different forms of respiratory diseases over Buchanan as predicted byWHO. The difference between the first and third quartile of the dataset indicates that there is considerable dispersion of aerosol content into the atmosphere between June and December. The likely pollution sources in the study area are traced to bush/domestic burning, Sahara desert and coastal pollution. The dataset and analysis of the aerosol loading would assist project design and policy making. In the future, more aggressive ground measurement is essential for understanding the vertical profile of atmospheric aerosol layers. More so, air quality awareness program should be initiated to lower the cumulative aerosol loading over the region.

Acknowledgement
This paper is partly funded by Covenant University.

References

[1]. Ostro B. 2014. Outdoor air pollution. Assessing the environmental burden of disease atnational and local levels.Geneva: World Health Organization, 2004.
[2]. Yang, Y., Liao, H. and Lou, S.-J., 2014. Simulated impacts of sulphate and nitrate aerosol formation on surface-layer ozone concentrations in China. Atmospheric and Oceanic Science Letters, 7(5) 441-446.
[3]. Adebiyi, A.A., Paquita, Z. and Steven, J.A., 2015, The convolution of dynamics and moisture with the presence of shortwave absorbing aerosols over the southeast atlantic. Journal of Climate, 28 1997–2024.
[4]. Dani, K.K., Maheskumar, R.S., and Devara, P.C.S., 2003. Study of total column atmospheric aerosol optical depth, ozone and precipitable water content over Bay of Bengal during BOBMEX-99. Journal of Earth System Science, 112 (2) 205-221.
[5]. Vijayakumar, K. and Devara, P.C.S., 2013. Study of aerosol optical depth, ozone, and precipitable water vapour content over Sinhagad, a high-altitude station in the Western Ghats. International Journal of Remote Sensing, 34 (2) 613-630.
[6]. Emetere M.E., Akinyemi M.L., Uno U.E., Computational Analysis of Aerosol Dispersion Trends From Cement Factory; (2015a) IEEE Proceedings 2015 International Conference on Space Science & Communication pp. 288 – 291
[7]. Emetere Moses E., Akinyemi M.L. &Oladimeji T.E. 2016a. Statistical Examination Of The Aerosols Loading Over Kano-Nigeria: The Satellite Observation Analysis, Scientific Review Engineering and Environmental Sciences, 25 (2) 72
[8]. Emetere Moses E., Akinyemi M.L. &Akinwumi S.A. 2016b. Aerosols Loading Trends And Its Environmental Threats Over Cotonou-Benin, Nature Environment and Pollution Technology, 15 (3) 1111
[9]. Emetere M.E., 2016. Numerical modelling of west africa regional scale aerosol dispersion. A doctoral thesis submitted to Covenant University, Nigeria pp 65-289